A Study on contact drying with flexible screen

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Abstract Three types of material as platen in contact drying process were tested in Composition Board Laboratory of Northeast Forestry University in 1998. Poplar veneers were dried under 0.3 MPa at 160℃ or 180℃. Through comparison a non-metal flexible material was chosen as screen for designing contact dryer and replacing curved metal plate. The new type contact dryer solved the problem of long auxiliary time by loading wet veneers into press and unloading dried veneers out of press at the same time. This increased productivity. Veneer's moisture content (MC) varied with drying time in index law. The process of contact drying with non-metal flexible screen was analyzed by stages of preheating, high-speed drying, retarded drying and extremely slow drying.

Key words: Flexible screen, Contact dryer, Contact drying, Veneers

Introduction

Hot press drying is referred to dry veneers between platens. Heat is transported from platen to veneer continuously (Sandoe 1983). Many experiments have shown that hot press may reduce drying time and increase heat efficient. In addition, hot press dried veneer is flat and smooth, which is desirable to glue, assembly as well as curtain coat (Lu 1993). Compared with conventional air circulating drier, hot press drier is simpler in structure, cheaper in price and more economical in operation (Lu 1998).

In spite of so many advantages, hot press has been studying at laboratory level since its birthday. The reason is that though hot press drying may reduce a mount of drying time, auxiliary time for loading and unloading veneer is increased (Bi 1990).

A new type of contacting dryer with flexible screen had been designed, which solved the problem existed in hot press drying--conveying veneers. In the new machinery a flexible screen belt was used to form a circle, conveying veneers as well as transporting heat and mass. So loading wet veneers and unloading dried veneers can be completed at the same time (Lu 1998). In this way, the auxiliary time was reduced and productivity was raised sharply.

The key to contact dryer is choosing screen. Besides transporting veneer, conducting heat and vaporizing, the screen should also be resistant to erosion of acid or alkali, high temperature, tensile stress and has a long service life.

Material and Method

There were three types of screen used in this work:
Screen 1: alloys screen, wire diameter of 3mm, woven tightly.
Screen 2: non-metal screen, warp of 0.8mm, weft of 0.8mm, ventilation of 500 m^3/m^2, opening ratio $\leqslant$3%.

Screen 3: non-metal material same as screen 2, warp of 0.5 mm, weft of 0.5mm, ventilation of 700 m^3/m^2, opening ratio $\leqslant$10%.
Laboratory hot press: three openings, 420 mm×420 mm in size.

Raw material: poplar veneer, 350mm×350mm×1.85 mm.

Screens were inserted between hot platens, and a piece of veneer was dried in hot press under arranged conditions. Final moisture contents (FMC) of veneers with similar initial moisture content (IMC) were compared. Based on FMC variation the best screen material was selected at last for industrial production.

Results and analysis

Experiment conditions and results were listed in Table 1 and Table 2.

It was observed in operation that temperature on the surface of screen 1 rose faster and achieved required temperature earlier than screen 3. But after hot platen closed, the vapor removed out of screen 1 slowly. It began to exhaust later 1~2 s than screen 3 did. From similar IMC, veneers dried by screen 3 got lower FMC in the same drying time. So screen 3 is more efficient than screen 1.

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According to the data, we could recognize that the FMC of veneer dried by screen 3 is lower than that dried by screen 2. The average drying rate of Screen 3 is 29% quicker than that of screen 2 at 160℃ and 37% at 180℃, which proved that the result of screen 3 was better.

Table 1. Drying results of Screen 1 and Screen 3

Drying Conditions			IMC (%)	FMC (%)	
Pressure (MPa)	Temperature (℃)	Drying time (s)		Screen 1	Screen 3
0.3	160	60	130~140	61.6	40
	180			57	26

Table 2. Drying results of Screen 2 and Screen 3

Conditions			IMC (%)	FMC (%)	
Pressure (MPa)	Temperature(℃)	Drying time (s)		Screen 2	Screen 3
0.3	160	60	70~75	24.6	11
	180		75~80	22.2	2.2

In the process of contact drying, heat-conducting rate was rapid because screen, hot platen and veneer contacted closely. The moisture in veneer could be transformed into vapor in a few seconds, then gushed out of press. At that time, the key to control drying rate was removing vapor. Though screen 1 conducted heat faster, it removed mass slowly. So vapor couldn't escape promptly, which is the obstacle of fast drying. The advantage of screen 3 was that vapor in veneer could be removed along the fiber of warp and weft fluently. Besides, screen 3 was thinner than screen 2 and conducted heat rapidly accordingly. Therefore comprehensive properties of screen 3 were satisfactory.

Screen 3 was confined as a desirable non-metal material. It was suitable for conveying veneer and conducting heat and mass. Screen 3 was selected for industrial trial.

Contact drying process

Veneers with different IMC were divided into several groups at an interval of 10% and final moisture contents (FMC) were tested after dried under designed conditions. The regression graphs of moisture content (MC) variation with drying time were drawn. All of these graphs were in a similar shape, as shown in Fig 1. Two temperatures saw similar index laws.

The process of contact drying with flexible screen might be basically divided into four parts:

The first stage was preheating. Heat was mainly used in elevating the temperature of veneer until up to boiling point when white vapor was observed gushing out of press. This period was very short and could be finished in 2~3 s after platens closed. In the first stage MC remained stable.

The second stage was high-speed drying. The graph of this section was steep, which meant MC decreased sharply due to rapid evaporating rate. The amount of vapor gushing out of press reached the greatest. The MC of veneer dropped quickly to 55%~65%, but drying rate varied small.

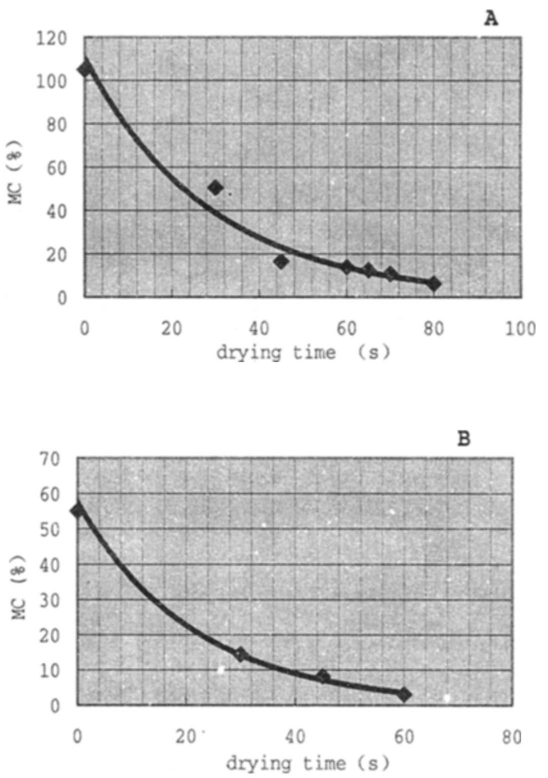

Fig 1. Regression graphs of veneer at 160℃

A. IMC of veneer was 105%; B. IMC of veneer was 55%

The third stage was retarded drying and graph sloped gently. Drying rate declined obviously and vapor poured out gradually reduced until couldn't be seen.

The fourth stage was slow drying. At this period it took the longest time of four stages to reach the required FMC. Drying rate was almost unchanged.

Take the veneer of 105% MC for an instance. After the press was closed, vapor began to gush out in 2 s, which meant preheating stage was over within 2 s Then there was a marketable drop in MC from 105% to 55% in 20 s only. In this period average drying rate was 2.63%/s, highest in the four parts. After that, veneer started retarded drying stage, MC of veneer coming down to 23% in 25 s. In this period, average drying rate fell to 1.28%/s and MC reduced 22%. The extremely slow drying period started at 23% MC and ended at 6.8% MC. In the forth stage average drying rate declined from 1.28%/s to 0.464%/s and MC reduced 16% in 35 s. The last period took up 44% of the whole drying time because of slow drying rate.

The dividing line of different stage varied depending on IMC, thickness, temperature and other influential factors. For example, the veneer with low IMC (under 65%) might have no obvious preheated stage and high-speed stage, while came into the retarded drying period directly, like shown in Fig 1B.

Summary

In laboratory experiments, veneers dried by contact drying method with flexible screen were observed having less breakage, warp, deformation, and FMC being well distributed (Hua 1994). Using flexible screen in contact dryer could solve the problem of loading and unloading veneer. Screen 3 was more efficient than other two kinds of materials, so was chosen for new type dryer design. Contact drying could be divided into four stages and MC varied with drying time in index law. What we studied may promote the contact drying technique into practical application.

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